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Risk adjustment in analysis of surgery for congenital heart disease

To the Editor:

The article by Jenkins and associates,[1] in the July 2002 issue of the *Journal,* is clearly an important advancement in risk adjustment when analyzing mortality outcome in the field of surgery for congenital heart disease. Further statistical analysis is needed in centers with high case volumes as the RACHS (Risk Adjustment in Congenital Heart Surgery) methodology evolves.

The concern regarding the large spectrum of mortality among risk categories 2 to 4, with some institutions displaying a threshold increase or decrease in mortality as higher-risk procedures, is disturbing for a potential severity model. This mismatch of observed/expected ratios is not surprising for severity scores in surgery in general.[2] Several factors involved that stem from inherent surgical practice and original logistic regression model of 5 variables were not discussed in the article.

The inherent surgical practice could be divided into physiologic and operative features. The operative variables, including in-hospital redo cases and estimated blood loss, should be evaluated. The first can have a dual knock effect on mortality. The estimated blood loss factor can have direct effects by contributing to child hypoxia and later the side effects of blood transfusion. Multivariate preoperative physiologic variables were not described in the original article by Jenkins and coworkers,[3] for example, hemoglobin, plasma sodium, and potassium. Recently, a hemoglobin concentration of 100 g/L or less had a 5-fold higher in-hospital mortality rate that those with higher concentrations.[4]

A widely recognized European severity score, POSSUM (a *P*hysiological and *O*perative *S*everity *S*core for the en*U*meration of *M*ortality and morbidity), used in vascular and colorectal surgery, is a simple scoring system incorporating only a total of 18 variables, of which preoperative electrolytes determined outcome.[5] There may be room for more specific and relevant variables to be included in RACHS-1.

Another aspect that could lead to the diversity of outcome in the intermediate risk category factors is whether a linear versus exponential model was adopted in the original equation. A linear method of analysis of the risk for each mortality group is artificially taken to the median as opposed to the mean in that risk category group. Although it may apply well to high-risk patients with smaller n values, it may overpredict death in the low-risk population, as was illustrated in centers A, F, O, S, and U in category 2 versus 3 and 4. Reanalyzing the data may produce different trends.

It is possible that these factors were considered; however, a discussion of these factors would be necessary for the reader. This would reduce chance-related outcome and might revisit the question regarding institutional inquiries, especially with regard to assignment of certain types of cases to specific surgeons and location of postoperative care.

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Ranking institutions

To the Editor:

Jenkins and Gauvreau[1] illustrated the use of a novel risk adjustment method in congenital heart surgery and chose to present their results largely in terms of institutional rankings. However, ranks are a notoriously inaccurate comparator for performance—someone always has to be bottom and top of a league table, no matter how much the play of chance may have contributed to their performance. Figure 1 shows the risk-adjusted standardized mortality ratios (SMRs) with 95% confidence intervals, as ranked by Jenkins and Gauvreau[1] according to outcomes from 22 institutions in 1996. We first note that a formal test that all the centers have SMRs of precisely 1 is barely significant ($\chi^2 = 35.6$, $df = 22$, $P = .03$, after transformation of all values to power 0.3 to bring to approximate normality), so there is not even strong evidence of any heterogeneity among centers. We can also estimate the "true rank" of each center. This requires the methodology described by Marshall and Spiegelhalter,[2] in which the "true SMRs" are repeatedly simulated from the confidence intervals in Figure 1 and then ranked at each iteration of the simulation. The resulting estimated true ranks and their 95% confidence intervals

TABLE 1. Probabilities of being "true best" and "true worst" centers for the 8 highest and lowest ranking centers

Center	Probability that "true best" center	Center	Probability that "true worst" center
C	0.27	J	0.01
D	0.16	Q	0.01
H	0.20	L	0.06
E	0.06	A	0.15
M	0.03	O	0.09
F	0.11	N	0.05
G	0.00	P	0.27
S	0.12	B	0.21